

**WHAT IS CLAIMED IS:**

1. A method of calculating  $x^{M/N}$ , wherein  $x$  has a value in a range  $(0, x_{\max}]$  and  $M$  and  $N$  are integers, comprising the steps of:
  - partitioning the range  $(0, x_{\max}]$  into a plurality of  $K$  number of intervals
- 5 [B<sup>k</sup>, B<sup>(k+1)N</sup>], where  $B > 1$  and  $k = -1, 0, 1 \dots K$ ;
  - determining the interval  $[B^k, B^{(k+1)N}]$  in which  $x$  falls and deriving a value of  $k$  therefrom;
  - dividing  $x$  by a normalization factor  $B^{kN}$  to obtain a normalized value  $x'$ ;
- 10 computing a value of  $x'^{M/N}$  for the normalized value  $x'$ ; and renormalizing by multiplying  $x'^{M/N}$ , by  $B^{kM}$  to obtain  $x^{M/N}$ .
- 15 2. The method of Claim 1 wherein said step of computing comprises the step of retrieving the value of  $x'^{M/N}$  from a look-up table indexed by the normalized value  $x'$ .

3. The method of Claim 1 wherein  $x^{M/N}$  is calculated in binary form and B is equal to 2.

4. The method of Claim 1 wherein said step of calculating comprises the step  
5 of performing a series expansion to calculate the value  $x' (M/N)$  for the normalized  
value  $x'$ .

5. The method of Claim 2 and further comprising the step of interpolating  
between the value  $x' (M/N)$  retrieved for a first quantized approximation of the  
10 normalized value  $x'$  and a second quantized approximation of the value of  $x' (M/N)$   
retrieved for a second value of  $x'$ .

6. The method of Claim 1 wherein the method is implemented in a program  
executed by a digital signal processor.

15 7. The method of Claim 1 wherein said steps are performed using fixed point  
operations.

8. A method of calculating  $x^{M/N}$ ,  $x$  having a range and  $M$  and  $N$  are integers, comprising the steps of:

partitioning the range of  $x$  into selected number of intervals;

determining the interval into which  $x$  falls;

5       normalizing  $x$  with a normalization factor calculated for the interval into which  $x$  falls to obtain a normalized value  $x'$  within a normalized range;

determining a value for  $x' (M/N)$  from  $x'$  within the normalized range; and

10      renormalizing by multiplying  $x' (M/N)$  by a renormalization factor calculated for the interval in which  $x$  falls obtain  $x^{M/N}$ .

9. The method of Claim 8 wherein said step of determining comprises the substeps of:

storing a plurality of values of  $x' (M/N)$  over the normalized range in a table;  
and

15      retrieving a value of  $x' (M/N)$  from the table for the normalized value  $x'$

20      10. The method of Claim 8 wherein the normalization factor is  $B^{Kn}$  where  $B$  is the base in which  $x^{M/N}$  is calculated and  $k$  is an index between 0 and  $K-1$  of the interval into which  $x$  falls, the range of  $x$  divided into  $K$  number of intervals.

11. The method of Claim 8 wherein the renormalization factor is  $B^{kM}$ .

12. The method of Claim 9 and further comprising the step of retrieving a second value  $x''^{(M/N)}$  corresponding to a second normalized value  $x''$  and  
5 interpolating between the retrieved value of  $x'^{(M/N)}$  and the second retrieved value  $x''^{(M/N)}$ .

13. The method of Claim 12 wherein said step of interpolating comprises the step of linearly interpolating in accordance with the formula:

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$$x'^{(M/N)} = \alpha(x'^{(M/N)}) + (1 - \alpha)x''^{(M/N)}$$

where  $\alpha$  is an interpolation factor.

14. The method of Claim 8 wherein  $M > N$  and the method comprises the steps of factoring  $x^{M_1} * x^{(M_2/N)}$ , where  $M = M_1*N + M_2$  and  $M_2 < N$ , and  
15 calculating  $x^{(M_2/N)}$ .

15. The method of Claim 8 wherein said steps of normalizing and renormalizing are implemented in fixed point operations.

16. A method of calculating a value of a function  $f(x)$  for a binary input value  $x$  within an un-normalized range comprising the steps of:

shifting a received input value  $x$  by a selected number of places in a selected direction to normalize the value of  $x$  to a normalized value  $x'$  in the  
5 normalized range;

calculating a value  $f(x')$  for the function  $f(x)$  for data point  $x'$  in the normalized range; and

shifting the calculated value of  $x'$  in a selected direction to obtain the value of  $f(x)$  for the input value  $x$ .

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17. The method of Claim 16 wherein  $f(x) = x^{M/N}$ , where  $M$  and  $N$  are integers.

18. The method of Claim 17 wherein the normalized range is selected to be  
[1,  $B^N$ ].

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19. The method of Claim 16 wherein said step of calculating comprises the substeps:

storing values  $f(x')$  of the function  $f(x)$  for a set of normalized values  $x'$  over a selected normalized range in a table; and

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indexing the table with part of  $x'$  and retrieving the value of  $f(x')$ .

20. The method of Claim 19 wherein said step of calculating further comprises the substeps of

retrieving a second value of  $f(x'')$  from the table for interpolation;

linearly interpolating between the value and second value of  $f(x'')$  using a fractional part of  $x'$  as an interpolation factor to obtain an interpolated value of  $x'$ ;

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21. The method of Claim 19 wherein said step of calculating comprises the step of calculating a value of  $f(x'')$  using a series expansion.

22. A signal processing system comprising:  
processing circuitry for obtaining a value for the function  $f(x)$  for an input  
data point  $x$  taken over an unnormalized range and operable to:  
shift the input data point  $x$  by a selected number of places to normalize the  
5 value of  $x$  to a normalized data point  $x'$  in the normalized range;  
calculate a value of  $f(x')$ ; and  
shift the value of  $f(x')$  a selected number of places to renormalize and  
obtain a result of  $f(x)$  over the unnormalized range for the input value  $x$ .
- 10  
23. The signal processing system of Claim 22 wherein the signal processing  
circuitry operates on fixed point values of  $x$  and  $x'$ .
- 15  
24. The signal processing system of Claim 22 wherein said processing  
circuitry comprises a digital signal processor.
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25. The signal processing system of Claim 24 wherein said digital signal  
processor forms a part of an audio data processing device
26. The signal processing system of Claim 25 wherein said digital signal  
processor forms a part of a dual signal processor audio data processing device.